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**UTILIZATION OF THE *SARGASSUM* HABITAT BY  
MARINE INVERTEBRATES AND VERTEBRATES - A REVIEW**

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## Introduction

Numerous species of brown algae (Class Cyclosporeae: Order Fucales: Family Fucaceae) of the genus *Sargassum* occur throughout the world's tropical and temperate oceans. The pelagic complex in the western North Atlantic is comprised primarily of *Sargassum natans* and *S. fluitans*. Both species are hyponeustonic and fully adapted to a pelagic existence (Parr, 1939). Known commonly as gulf-weed, sea holly, or sargassum, they are characterized by a brushy, highly branched thallus (stem) with numerous leaf-like blades and berry-like pneumatocysts (floats). These floating plants may be up to several meters in length but are typically much smaller. See Hoyt (1918), Winge (1923), Parr (1939), Taylor (1960), Prescott (1968), and Humm (1979) for detailed descriptions of the various species.

Sargassum floats contain mostly oxygen with some nitrogen and carbon dioxide, and are responsible for buoyancy. Oxygen content is dependent on the oxygen partial pressure of the surrounding medium and independent of photosynthetic activity (Hurka, 1971). Woodcock (1950) also found diurnal fluctuations in gas pressure within the floats, and attributed it to similar changes in oxygen partial pressure during daylight and darkness.

There is some debate as to whether sargassum found in the Gulf Stream, Gulf of Mexico, Caribbean Sea, and the North Atlantic Central Gyre is material detached from littoral plants in the Antilles and other tropical regions during storms (Peres, 1982) or whether the oceanic components are a separate species group independent of their coastal littoral relatives. Most researchers

consider the pelagic forms a separate and distinct species group having evolved from benthic species (Winge, 1923; Parr, 1939; Friedrich, 1969; Butler et al., 1983; Stoner and Greening, 1984). Supporting evidence includes the lack of sexual reproduction characteristic of benthic forms, the loss of a basal holdfast, and the number of endemic organisms in the associated community (10 invertebrates and 2 vertebrates). Benthic forms, such as *S. filipendula*, occur in the open ocean in small quantities, but should be considered flotsam (Hoyt, 1918; Winge, 1923; Parr, 1939; Dooley, 1972).

Sargassum circulates between 20° and 40° N latitude and 30°W longitude and the western edge of the Florida Current/Gulf Stream, with an apparent center of distribution within the North Atlantic Central Gyre between 28° and 34°N latitude (Fig. 1) (Winge 1923; Ryther, 1956; Dooley, 1972; Butler et al. 1983). Large quantities also occur on the continental shelf. Some of this material is cast upon beaches along the eastern seaboard (Hoyt, 1918; Humm, 1979; Winston, 1982), while much of it remains on the shelf or is entrained into the Gulf Stream. Throughout the region, sargassum frequently aggregates into large windrows in response to wind forcing (Winge, 1923; Langmuir, 1938; Faller and Woodcock, 1964) or shear currents along frontal boundaries (Stommel, 1965). Woodcock (1950) demonstrated that sargassum can be downwelled along such convergence zones; the depth of descent being dependent on the buoyancy of individual algal clumps and the magnitude of the Langmuir circulation cell. Clumps that do not sink below a

critical depth ( $\approx 100$  m) can withstand the hydrostatic pressure and will ultimately rise to the surface. There is also, however, a time-at-depth relationship that can influence the true critical depth at which buoyancy is lost and the algae sink to the bottom (Johnson and Richardson, 1977). Peres (1982) questioned the ability of any sargassum to return to the surface after being downwelled. When buoyancy is lost, sargassum sinks slowly to the bottom (about 2 days to reach 5000 m) and provides a resource for bottom dwelling consumers (Schoener and Rowe, 1970).

The contribution of sargassum to total primary production in the western North Atlantic is variable and dependent on the region examined and on accumulated biomass. Carpenter and Cox (1974) estimated average production across the western Sargasso Sea at  $\approx 1.0 \text{ mg C m}^{-2}\text{d}^{-1}$ , with higher values frequently occurring at localities on the continental shelf and in the northern Sargasso Sea (above  $30^{\circ}\text{N}$ ). Howard and Menzies (1969) found production highest in the Gulf Stream, lowest on the shelf, and intermediate in the Sargasso Sea. These authors estimate sargassum probably contributes about 0.5% of the total primary production in the region, but nearly 60% of the total in the upper 1 m of the water column (Howard and Menzies, 1969; Carpenter and Cox, 1974; Hanson, 1977; Peres, 1982). In addition, epiphytic cyanobacteria (*Dichothrix* and *Oscillatoria*) contribute significantly to overall production and nitrogen fixation within the immediate sargassum community (Carpenter, 1972; Carpenter and Cox, 1974; Philips and Zeman, 1990). Both sargassum and its associated blue-green algae

epiphytes are adapted to conditions of strong sunlight, that is, photosynthesis is not inhibited at high light intensities (Phlips, et al., 1986).

A survey conducted in the Sargasso Sea from 1933 to 1935 (Parr, 1939) estimated sargassum biomass at 524 to 1642 mg m<sup>-2</sup>. Stoner's (1983) estimates in the Sargasso Sea from the years 1977 to 1981 were less than 6% of those earlier estimates. He suggested that the decline may have been anthropogenically influenced. Subsequent analysis of Stoner's data, however, concluded that there had been no significant change in the biomass of sargassum from 1933 to 1981, except in an area northeast of the Antilles. This apparent decline was attributed to seasonal variation in sargassum abundance or long-term current shifts, and apparently not to pollution (Butler et al. 1983; Butler and Stoner, 1984). Reliable estimates of total biomass are not available, however, as no directed statistical study encompassing the vast range of these species has been conducted.

#### Habitat Utilization

Pelagic sargassum supports a diverse community of marine organisms including micro- and macro-epiphytes (Carpenter, 1970; Carpenter and Cox, 1974; Mogelberg et al., 1983), fungi (Winge, 1923; Kohlmeier, 1971), more than 100 species of invertebrates (Table 1), over 100 species of fishes (Table 2), and four species of sea turtles (Carr, 1987a; Manzella and Williams, 1991). Some inhabitants, unique to the sargassum habitat, have evolved unusual

shapes and coloration affording them the additional advantage of camouflage among the floating plants. Others are less specialized and utilize the habitat for foraging or protection from predators. Community structure is variable; influenced by season, geographic location, and algal "age" (Weis, 1968; Fine, 1970; Butler et al. 1983; Stoner and Greening, 1984). Weis (1968) also noted differences in epibiont diversity between species of sargassum. An important factor in the structure of the community is related to compounds occurring in the exudate released by the algae during growth. Tannins produced on the distal growing tips of sargassum have an inhibitory effect on colonizing epibionts (Conover and Sieburth, 1964; Sieburth and Conover, 1965). This antifouling effect lasts a short time and a succession of bacteria, hydroids, bryozoans, and blue-green algae rapidly follow (Winge, 1923; Conover and Sieburth, 1964; Ryland, 1974). Carpenter and Cox (1974) also suggest that low epibiont density within some areas of the Sargasso Sea may be nutrient limited rather than limited by the antibiotic activity of sargassum exudates. Natural chemical compounds, including phenolic compounds, produced by algae may also serve as a deterrent to herbivores (Paul, 1987; Hay and Fenical, 1988; Hay et al., 1988; Steinberg, 1988).

For details of community metabolism, respiration, trophic web and chemistry, we refer the reader to the works of Culliney (1970), Burns and Teal (1973), Smith et al. (1973), Johnson and Braman (1975), Blake and Johnson (1976), Hanson, (1977), Geiselman (1983), Morris et al. (1976), and Trapnell et al. (1983).

## Invertebrates

The invertebrate fauna consists of both sessile and motile forms (Table 1). Epizoans include colonial hydroids, encrusting bryozoans, the polychaete *Spirorbis*, barnacles, pycnogonids, and the tunicate *Diplosoma*. Older plants gradually become heavily encrusted with these organisms and ultimately sink. This biomass then gradually disintegrates, providing valuable nourishment for animals in deeper water (Parr, 1939; Weis, 1968; Schoener and Rowe, 1970; Butler et al. 1983). Conspicuous among the motile fauna are decapod crustaceans, particularly the *Portunus* crabs, and shrimps *Latreutes* and *Leander*, various molluscs, including the sargassum snail *Litiopa melanostoma*, polychaetes, flatworms, and nudibranchs. Fine (1970) found very high numbers of portunids in his late summer samples in the Gulf Stream and Sargasso Sea. Only *Portunus sayi* is commonly considered a resident of the community; the remaining megalopa and juveniles are transitory and utilize the habitat as a nursery.

Dooley (1972) examined stomach contents of the eight most abundant fish species yielding further insight into the invertebrate component of the sargassum community. These included hydroids, copepods, phyllosoma larvae, shrimp zoea and postlarvae, crabs, pycnogonids, barnacles, tunicates, polychaetes, bivalves, gastropods, and platyhelminthes. The presence of two rather enigmatic members of the sargassum fauna were revealed by Morgan



et al. (1985) through stomach content analysis of several large epipelagic predatory fishes. They found the large mysis of the penaeoids, *Cerataspis monstrosa* and *C. petiti*, frequently co-occurred with sargassum in the stomachs of surface feeding tuna (Scombridae) and dolphin *Coryphaena hippurus*. Nothing is known about the adult stage or life history of these rare crustaceans.

### Vertebrates - Fishes

There is a well known assemblage of small fishes associated with sargassum rafts, many of which serve as forage for commercially or recreationally exploited species (Table 2). Dooley (1972) described 54 species from 23 families in the sargassum community of the Florida Current, while Bortone et al. (1977) reported 40 species from 15 families in the eastern Gulf of Mexico. Only 14 species from 11 families are known from the Sargasso Sea (Fedoryako, 1980; 1989).

Young jacks (Carangidae) live among the protective branches of sargassum and feed heavily on copepods and larval decapods. Apparently sargassum carries along a resident plankton population capable of sustaining these voracious predators (Yeatman, 1962). Sub-adult jacks range further from the rafts but dart in to feed on shrimp and young fishes living in the sargassum. The filefishes and triggerfishes (Balistidae) are also abundant and feed primarily on hydroids, encrusting bryozoans, and other invertebrates. Another major predator is the voracious sargassumfish, *Histrio histrio*, which selectively preys upon shrimp and young fish (Adams, 1960).

Large predatory species associated with the sargassum habitat include jacks, dolphins (Coryphaenidae), barracudas (Sphyraenidae), mackerels and tunas (Scombridae), swordfish (Xiphiidae), and billfishes (Istiophoridae) (Gibbs and Collette, 1959; Stephens, 1965; Dooley, 1972; Fedoryako, 1980; Carr, 1986; C. Manooch, pers. comm.). It is believed that dolphin, a much sought after game and food fish, takes shelter under flatoam (including sargassum) because of the enhanced availability of prey (Dooley, 1972). Filefish, triggerfish, jacks, flyingfish (Exocoetidae), and puffers (Tetradontidae) are among the species identified in dolphin stomachs (Gibbs and Collette, 1959; Dooley, 1972; Manooch et al., 1984). Fragments of sargassum were also commonly found. Manooch et al. (1984) stated "The close association (=dependence) of dolphin with fish and invertebrates that form the sargassum community is unmistakable". Manooch and Mason (1983) also reported finding sargassum fragments in 26% of yellowfin tuna, *Thunnus albacaras*, stomachs they examined as well as in 12% of blackfin tuna, *T. atlanticus*. They believed the material was ingested incidentally with normal prey.

There is less known about the ichthyoplankton associated with the habitat, but it seems likely that the same hydrodynamic mechanisms that drive the formation of sargassum rafts, i.e., convergence of surface water within shear zones or Langmuir cells, will also aggregate surface oriented organisms (Kingsford, 1990). There is some evidence that this is the case for swordfish, *Xiphias*

*gladius*, larvae and cobia, *Rachycentron canadum*, eggs near the Gulf Stream frontal zone (Hassler and Rainville, 1975; J.J. Govoni, pers. comm.). In addition to feeding and shelter, adults of some oceanic pelagic fishes use sargassum as a spawning substrate (Dooley, 1972; Peres, 1982) or as a nursery area for larvae and juveniles. Most notable among these are the flyingfishes (Winge, 1923; Breder, 1938) which are a major component of the diet of large oceanic fishes.

#### Vertebrates-Sea Turtles

During the pelagic stage, hatchling loggerhead, *Caretta caretta*, green, *Chelonia mydas*, Kemp's ridley, *Lepidochelys kemp*i, and hawksbill, *Eretmochelys imbricata*, sea turtles have been observed in sargassum off Florida, Georgia, North Carolina, and Texas (Smith, 1968; Fletemeyer, 1978; Carr and Meylan, 1980; Carr, 1986; 1987a; Schwartz, 1988; 1989; Manzella and Williams, 1991; Schwartz, pers. comm.). Hundreds of loggerhead hatchlings, both dead and alive, were found in the wrack of sargassum deposited on the shore at Cocoa Beach, Florida following a hurricane in September, 1979 (Carr and Meylan, 1980). Stomach contents of the dead hatchlings showed that almost all contained sargassum floats and leafy parts. Schwartz (1988) reported numerous loggerhead hatchlings captured during commercial trawling for sargassum. This observation constitutes the largest known aggregation of loggerhead hatchlings encountered off the North Carolina coast.

Hatchling turtles are thought to actively seek out frontal zones and hence sargassum rafts. These areas are then utilized for forage and protection during the "lost year" (Carr 1986; 1987a,b). Witham (1988) suggested an alternative hypothesis for this association. He noted that it remains untested as to whether sea turtles actually benefit from their association with sargassum or whether they are at increased risk from predation, entanglement, and stranding.

#### Summary

The pelagic sargassum habitat of the northwestern Atlantic consists of both truly pelagic forms and flotsom detached from coastal regions. While within the neuston it provides numerous species of invertebrates and vertebrates a source of food, shelter, and substrate. Community structure varies with season, location, and algal age.

While the relationship of many species within this habitat is well understood, others remain less well known. This is particularly true for egg and larval stages of fishes, some crustaceans, and juvenile sea turtles. Functional relationships between the animals and the habitat have not been elucidated (e.g., we do not know the effect of the loss of sargassum on fish or sea turtle populations). Because estimates of oceanic biomass of sargassum are variable and inadequate, we also do not have a clear understanding the population dynamics of the sargassum habitat,

i.e., what is the standing crop, the productivity and the effect of harvesting on living marine resources?

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## Literature Cited

- Adams, J.A. 1960. A contribution to the biology and post-larval development of the sargassum fish, *Histrio histrio* (Linnaeus), with a discussion of the *Sargassum* complex. Bull. Mar. Sci. Gulf Carib. 10:55-82.
- Beardsley, G.L., Jr. 1967. Age, growth, and reproduction of the dolphin, *Coryphaena hippurus*, in the Straits of Florida. Copeia 1967:441-451.
- Beebe, W. and J. Vee-Van. 1928. The fishes of Port-Au-Prince Bay, Haiti. Zoologica 10:1-279.
- Berry, F.H. 1959. Young jack crevalles (*Caranx* species) off the southeastern Atlantic coast of the United States. Fish. Bull., U.S. 59:417-535.
- Berry, F.H. and L.E. Vogele. 1961. Filefishes (Monacanthidae) of the western north Atlantic. Fish. Bull., U.S. 61:61-109.
- Blake, N.J. and D.L. Johnson. 1976. Oxygen production-consumption of the pelagic *Sargassum* community in a flow-through system with arsenic additions. Deep-Sea Res. 23:773-778.
- Böhlke, J.E. and C.C.G. Chaplin. 1968. Fishes of the Bahamas and adjacent tropical waters. Livingston, Wynnewood, PA, 771 p.
- Bortone, S.A., P.A. Hastings and S.B. Collard. 1977. The pelagic *Sargassum* ichthyofauna of the eastern Gulf of Mexico. Northeast Gulf Sci. 1:60-67.

- Breder, C.M., Jr. 1938. A contribution to the life histories of Atlantic Ocean flyingfishes. Bull. Bingham Oceanogr. Coll., Yale Univ. 6(5):1-126.
- Brusca, R.C. and G.J. Brusca. 1990. Invertebrates. Sinauer Associates, Inc., Sunderland, MA. 922 p.
- Burns, K.A. and J.M. Teal. 1973. Hydrocarbons in the pelagic *Sargassum* community. Deep-Sea Res. 20:207-211.
- Butler, J.N., B.F. Morris, J. Cadwalller and A.W. Stoner. 1983. Studies of *Sargassum* and the *Sargassum* community. Bermuda Biol. Sta. Spec. Publ. 22:1-85.
- Butler, J.N. and A.W. Stoner. 1984. Pelagic *Sargassum*: has its biomass changed in the last 50 years? Deep-Sea Res. 31:1259-1264.
- Caldwell, D.K. 1959. Observations on tropical marine fishes from the northeastern Gulf of Mexico. Quart. J. Fla. Acad. Sci. 22:69-74.
- Carpenter, E.J. 1970. Diatoms attached to floating *Sargassum* in the western Sargasso Sea. Phycologia 9:271-274.
- Carpenter, E.J. 1972. Nitrogen fixation by a blue-green epiphyte on pelagic *Sargassum*. Science 178:1207-1209.
- Carpenter, E.J. and J.L. Cox. 1974. Production of pelagic *Sargassum* and a blue-green epiphyte in the western Sargasso Sea. Limnol. Oceanogr. 19:429-435.
- Carr, A. 1986. Rips, FADS, and little loggerheads. BioScience 36(2):92-100.

- Carr, A. 1987a. Perspective on the pelagic stage of sea turtle development. *Conserv. Biol.* 1(2):103-121.
- Carr, A. 1987b. Impact of nondegradable marine debris on the ecology and survival outlook of sea turtles. *Mar. Pollut. Bull.* 18:352-356.
- Carr, A. and A.B. Meylan. 1980. Evidence of passive migration of green turtle hatchlings in *Sargassum*. *Copeia* 1980:366-368.
- Conover, J.T. and J. McN. Sieburth. 1964. Effect of *Sargassum* distribution on its epibiota and antibacterial activity. *Bot. Mar.* 6:147-157.
- Culliney, J.L. 1970. Measurements of reactive phosphorus associated with pelagic *Sargassum* in the northwest Sargasso Sea. *Limnol. Oceanogr.* 15:304-306.
- Dawson, C.E. 1962. New records and notes on fishes from the north central Gulf of Mexico. *Copeia* 1962:442-444.
- Deason, E. 1983. Meiofauna of pelagic *Sargassum*. Bermuda Biol. Sta. Spec. Publ. 22:102-113.
- Dooley, J.K. 1972. Fishes associated with the pelagic sargassum complex, with a discussion of the sargassum community. *Contrib. Mar. Sci.* 16:1-32.
- Faller, A.J. and A.H. Woodcock. 1964. The spacing of windrows of *Sargassum* in the ocean. *J. Mar. Res.* 22:22-29.
- Fedoryako, B.I. 1980. The ichthyofauna of the surface waters of the Sargasso Sea southwest of Bermuda. *J. Ichthyol.* 20(4):1-9.



- Fedoryako, B.I. 1989. A comparative characteristic of oceanic fish assemblages associated with floating debris. J. Ichthyol. 29(3):128-137.
- Fine, M.L. 1970. Faunal variations on pelagic *Sargassum*. Mar. Biol. 7:112-122.
- Fletemeyer, J.R. 1978. Underwater tracking evidence of neonate loggerhead sea turtles seeking shelter in drifting *Sargassum*. Copeia 1978:148-149.
- Friedrich, M. 1969. Marine biology. (Translated from German by G. Vevers). Univ. Washington Press, Seattle, 474 p.
- Geiselman, J. 1983. The food web of the *Sargassum* community. Bermuda Biol. Sta. Spec. Publ. 22:260-270.
- Gibbs, R.M., Jr. and B.B. Collette. 1959. On the identification, distributions, and biology of the dolphins, *Coryphaena hippurus* and *C. equisetis*. Bull. Mar. Sci. Gulf and Carib. 9:117-152.
- Hanson, R.B. 1977. Pelagic *Sargassum* community metabolism - carbon and nitrogen. J. Exp. Mar. Biol. Ecol. 29:107-118.
- Hassler, W.W. and R.P. Rainville. 1975. Techniques for hatching and rearing cobia, *Rachycentron canadum*, through larval and juvenile stages. Univ. N.C., Sea Grant Publ. UNC-SG-75-30.
- Hastings, P.A. and S.A. Bortone. 1976. Additional notes on tropical marine fishes in the northern Gulf of Mexico. Fla. Sci. 39:123-125.

- Hay, M.E. and W. Fenical. 1988. Marine Plant - herbivore interactions: The ecology of chemical defense. *Annu. Rev. Ecol. Syst.* 19:111-145.
- Hay, M.E., P.E. Renaud and W. Fenical. 1988. Large mobile versus small sedimentary herbivores and their resistance to seaweed chemical defenses. *Oecologia* 75:246-252.
- Howard, K.L. and R.J. Menzies. 1969. Distribution and production of *Sargassum* in the waters off the Carolina coast. *Bot. Mar.* 12:244-254.
- Hoyt, W.D. 1918. Marine algae of Beaufort, N.C., and adjacent regions. *Bull. U.S. Bur. Fish.* 36:367-560.
- Humm, H.J. 1979. The marine algae of Virginia. *Va. Inst. Mar. Sci., Spec. Pap. Mar. Sci.* No. 3.
- Hurka, M. 1971. Factors influencing the gas composition in the vesicles of *Sargassum*. *Mar. Biol.* 11:82-89.
- Johnson, D.L. and R.S. Braman. 1975. The speciation of arsenic and the content of germanium and mercury in members of the pelagic *Sargassum* community. *Deep-Sea Res.* 22:503-507.
- Johnson, D.L. and P.L. Richardson. 1977. On the wind-induced sinking of *Sargassum*. *J. Exp. Mar. Biol. Ecol.* 28:255-267.
- Kingsford, M.J. 1990. Linear oceanographic features: a focus for research on recruitment processes. *Aust. J. Ecol.* 15:391-401.
- Kohlmeyer, J. 1971. Fungi from the Sargasso Sea. *Mar. Biol.* 8:344-350.

Langmuir, I. 1938. Surface motion of water induced by wind.

Science 87:119-123.

Manooch, C.S., III and W.T. Hogarth. 1983. Stomach contents and giant trematodes from wahoo, *Acanthocybium solanderi*, collected along the south Atlantic and Gulf coasts of the United States. Bull. Mar. Sci. 33:227-238.

Manooch, C.S., III and D.L. Mason. 1983. Comparative food of yellowfin tuna, *Thunnus albacares*, and blackfin tuna, *Thunnus atlanticus*, (Pisces: Scombridae) from the southeastern and Gulf of Mexico coasts of the United States. Brimleyana 9:33-52.

Manooch, C.S., III, D.L. Mason and R.S. Nelson. 1984. Food and gastrointestinal parasites of dolphin *Coryphaena hippurus* collected along the southeastern and Gulf coasts of the United States. Bull. Jpn. Soc. Sci. Fish. 50:1511-1525.

Manooch, C.S., III, D.L. Mason and R.S. Nelson. 1985. Food of little tunny *Euthynnus alletteratus* collected along the southeastern and Gulf coasts of the United States. Bull. Jpn. Soc. Sci. Fish. 51:1207-1218.

Manzella, S. and J. Williams. 1991. Juvenile head-started Kemp's ridleys found in floating grass mats. Mar. Turtle Newsletter 52:5-6.

Minerals Management Service. 1990. Final environmental report on proposed exploratory drilling offshore North Carolina, Vol. 1. U.S. Department of the Interior, Minerals Management Service, Atlantic OCS Region. Environmental Assessment Section, Herndon, VA.

- Mogelberg, D.D., B.F. Morris and J. Cadwalller. 1983. Sessile fauna and flora. Bermuda Biol. Sta. Spec. Publ. 22:225-234.
- Morgan, S.G., C.S. Manooch, III, D.L. Mason and J.W. Goy. 1985. Pelagic fish predation on *Cerataspis*, a rare larval genus of oceanic penaeoids. Bull. Mar. Sci. 36:249-259.
- Morris, B.F., J. Cadwallader, J. Geiselman and J.N. Butler. 1976. Transfer of petroleum and biogenic hydrocarbons in the *Sargassum* community. Pages 235-259 in H.L. Windom and R.A. Duce (eds.), Marine Pollutant Transfer. D.C. Heath and Co. Lexington, MA.
- Morris, B.F. and D.D. Mogelberg. 1973. Identification manual to the pelagic *Sargassum* fauna. Bermuda Biol. Sta. Spec. Publ. 11, 63 p.
- Parr, A.D. 1939. Quantitative observations on the pelagic *Sargassum* vegetation of the western North Atlantic. Bull. Bingham Oceanogr. Coll., Yale Univ. 6(7):1-94.
- Paul, V.J. 1987. Feeding deterrent effects of algal natural products. Bull. Mar. Sci. 41:514-522.
- Peres, J.M. 1982. Specific pelagic assemblages. Pages 314-372 in O. Kinne (ed.), Marine Ecology, Vol. 5, pt. 1, John Wiley and Sons, New York.
- Phlips, E.J., M. Willis, and A. Verchick. 1986. Aspects of nitrogen fixation in *Sargassum* communities off the coast of Florida. J. Exp. Mar. Biol. Ecol. 102:99-119.

- Phlips, E.J. and C. Zeman. 1990. Photosynthesis, growth and nitrogen fixation by epiphytic forms of filamentous cyanobacteria from pelagic sargassum. *Bull. Mar. Sci.* 47:613-621.
- Prescott, G.W. 1968. The algae: A review. Houghton Mifflin, Boston, Mass., 436 p.
- Randall, J.E. 1968. Caribbean reef fishes. T.F.H. Publications, Inc., Jersey City, N.J. 318 p.
- Robins, C.R., R.M. Bailey, C.E. Bond, J.R. Brooker, E.A. Lachner, R.N. Lea, and W.B. Scott. 1991. Common and scientific names of fishes from the United States and Canada, Fifth edition. *Am. Fish. Soc. Spec. Publ.* 20, 183 p.
- Ryland, J.S. 1974. Observations on some epibionts of gulf-weed, *Sargassum natans* (L.) Meyen. *J. Exp. Mar. Biol. Ecol.* 14:17-25.
- Ryther, J.M. 1956. The Sargasso Sea. *Sci. Am.* 194(1):98-104.
- Schoener, A. and G.T. Rowe. 1970. Pelagic *Sargassum* and its presence among the deep-sea benthos. *Deep-Sea Res.* 17:923-925.
- Schwartz, F.J. 1988. Aggregations of young hatchling loggerhead sea turtles in the sargassum off North Carolina. *Mar. Turtle Newsletter* 42:9-10.
- Schwartz, F.J. 1989. Biology and ecology of sea turtles frequenting North Carolina. Pages 307-331, in R.Y. George and A.W. Hulbert (ed.), North Carolina Coastal Oceanography Symposium, NOAA-NURP Rep. 89-2.

- Schwartz, F.J., W.T. Hogarth and M.P. Weinstein. 1982. Marine and freshwater fishes of the Cape Fear Estuary, North Carolina, and their distribution in relation to environmental factors. *Brimleyana* 7:17-37.
- Sieburth, J. McN. and J.T. Conover. 1965. *Sargassum* tannin, an antibiotic which retards fouling. *Nature* 208:52-53.
- Smith, K.L., Jr., K.A. Burns and E.J. Carpenter. 1973. Respiration of the pelagic *Sargassum* community. *Deep-Sea Res.* 20:213-217.
- Smith, W.G. 1968. A neonate Atlantic loggerhead turtle, *Caretta caretta*, captured at sea. *Copeia* 1968:880-881.
- Steinberg, P.D. 1988. Effects of quantitative and qualitative variation in phenolic compounds on feeding in three species of marine invertebrate herbivores. *J. Exp. Biol. Ecol.* 120:221-237.
- Stephens, W.M. 1965. Summer cruise to the Sargasso Sea. *Sea Frontiers* 11:108-123.
- Stommel, H. 1965. The Gulf Stream. Univ. Calif. Press, Berkeley, 248 p.
- Stoner, A.W. 1983. Pelagic sargassum: evidence for a major decrease in biomass. *Deep-Sea Res.* 30(4A):469-474.
- Stoner, A.W. and H.S. Greening. 1984. Geographic variation in the macrofaunal associates of pelagic *Sargassum* and some biogeographic implications. *Mar. Ecol. Prog. Ser.* 20:185-192.

- Taylor, W.R. 1960. Marine algae of the eastern tropical and subtropical coasts of the Americas. Univ. Mich. Press, Ann Arbor, 870 p.
- Teal, J. and M. Teal. 1975. The Sargasso Sea. Little, Brown, Boston, MA, 216 p.
- Trapnell, D., A.H. Knap and J.N. Butler. 1983. Hydrocarbons in some fauna of the *Sargassum* community. Bermuda Biol. Sta. Spec. Publ. 22:271-296.
- Weis, J.S. 1968. Fauna associated with pelagic sargassum in the Gulf Stream. Am. Midl. Nat. 80:554-558.
- Winge, O. 1923. The Sargasso Sea, its boundaries and vegetation. Rep. Dan. Oceanogr. Exped. 1908-1910 3(2): 3-34.
- Winston, J.E. 1982. Drift plastic - an expanding niche for a marine invertebrate? Mar. Pollut. Bull. 13:348-351.
- Witham, R. 1988. Drifting Sargassum weed: safe haven or increased risk for hatchling sea turtles? NOAA Tech. Memo. NMFS-SEFC-214:129-130.
- Woodcock, A.M. 1950. Subsurface pelagic *Sargassum*. J. Mar. Res. 9:77-92.
- Yeatman, H.C. 1962. The problem of dispersal of marine littoral copepods in the Atlantic Ocean, including some redescrptions of species. Crustaceana 4:253-272.

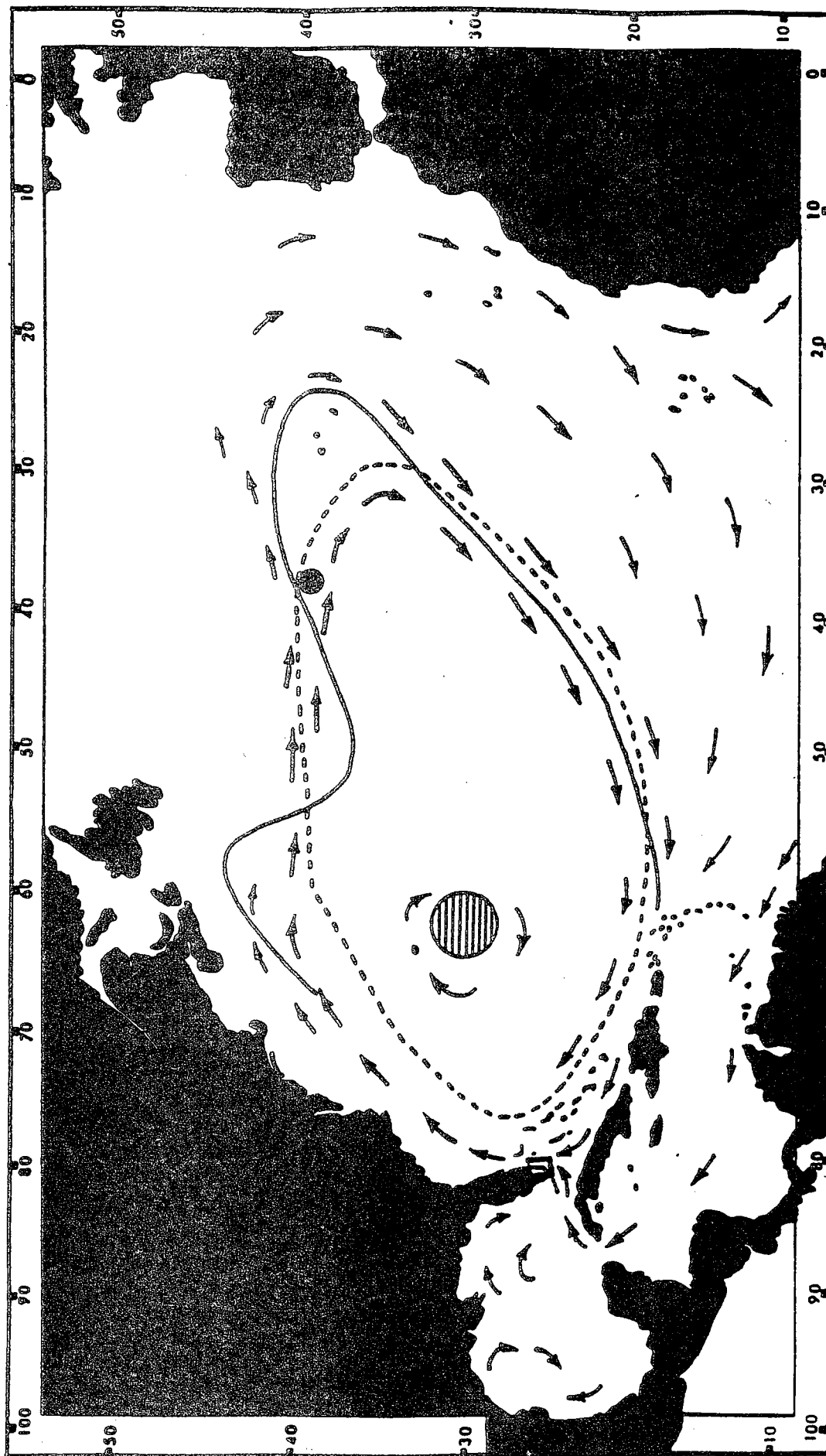


Figure 1. Distribution of pelagic Sargassum in the Northwest Atlantic. Solid line refers to the outer boundary of regular occurrence; dashed line refers to the area in which there is a > 5% probability of encounter within any 1° square; hatched circle represents possible center of distribution (From Dooley, 1972).



Table 1. Invertebrates and primitive chordates associated with pelagic *Sargassum*<sup>a</sup>. Taxonomy follows Brusca and Brusca (1990).

Phylum Sarcomastigophora  
 Class Granuloreticulosea  
 Order Foraminiferida  
*Planorbulina acervalis*  
*Rosalina* sp.

Phylum Cnidaria  
 Class Hydrozoa  
 Order Hydroida

<i>Aglaeophenia latecarinata</i>	<i>O. hyalina</i>
<i>A. minuta</i>	<i>Plumularia catharina</i>
<i>A. perpusilla</i>	<i>P. corrugata</i>
<i>A. rigida</i>	<i>P. diaphana</i>
<i>Aglaeophenoides mammillata</i>	<i>P. floridana</i>
<i>Antenella secundaria</i>	<i>P. margaretta</i>
<i>Campanularia volubilis</i>	<i>P. megalocephala</i>
<i>Cladocryne pelagica</i>	<i>P. obligua</i>
<i>Clytia bicophora</i>	<i>P. sargassi</i>
<i>C. cylindrica</i>	<i>P. setaceoides</i>
<i>C. johnstoni</i>	<i>P. strictocarpa</i>
<i>C. longicyatha</i>	<i>Scandia mutabilis</i>
<i>C. noliformis</i>	<i>Setularia amplexens</i>
<i>C. raridentata</i>	<i>S. brevicyathus</i>
<i>C. simplex</i>	<i>S. cornicina</i>
<i>Desmocyphus pumilus</i>	<i>S. exigua</i>
<i>Dynamena quadridentata</i>	<i>S. flowersi</i>
<i>Eucopella sargassicola</i>	<i>S. gracilis</i>
<i>Gemmaria</i> sp.	<i>S. inflata</i>
<i>Gonothyraea gracilis</i>	<i>S. mayeri</i>
<i>G. integra</i>	<i>S. rathbuni</i>
<i>Halecium nanum</i>	<i>S. stookeyi</i>
<i>Hebella calcarata</i>	<i>S. turbinata</i>
<i>Laomedea</i> sp.	<i>S. versluysi</i>
<i>Obelia bicuspidata</i>	<i>Syncoryne mirabilis</i>
<i>O. dichotoma</i>	<i>Zanclea costata</i>
<i>O. geniculata</i>	<i>Z. gemmosa</i>

Class Anthozoa  
 Order Actiniaria  
*Anemonia sargassensis*

Table 1. Contd.

## Phylum Platyhelminthes

## Class Turbellaria

## Order Acoela

*Amphiscolopus sargassi*

## Order Polycladida

*Acerotisa notulata**Holoplana grubei**Stylochus mertensi**S. pellucidus**Gnescioceros sargassicola*

## Phylum Annelida

## Class Polychaeta

## Order Phyllodocida

*Alciope contrainii**Harmothoe dearborni**Platyeris coccinea**P. dumerillii*

## Order Sabellida

*Spirorbis corrugatus*

## Order Amphinomida

*Amphinome rostrata*

## Phylum Arthropoda

## Class Pycnogonida

*Anoplodactylus petiolatus**Endeis spinosa**Tanystylum orbiculaire*

## Class Branchiopoda

## Order Cladocera

*Evadne spinifera*

## Class Maxillopoda

## Order Harpacticoida

*Amonardia phyllopus**Dactylopodia tisboides**Harpacticus gurneyi**Paradactylopodia oculata**Paralaophonte congenera**Scutellidium longicauda*

Table 1. Contd.

## Order Cyclopoida

*Macrochiron avirostrum**M. hudsoni**M. sargassi**Copilia mediterranea*

## Order Thoracica

*Conchoderma virgatum**Lepas anatifera**L. anserifera**L. australis**L. fascicularis**L. hilli**L. pectinata*

## Class Malacostraca

## Order Decapoda

*Alpheus* sp.*Cerataspis monstrosa**C. petiti**Hippolyte coerulescens**H. ensiferus**H. tenuirostris**H. zoztericola**Latreutes ensiferus**L. fucorum**Leander tenuicornis**Palaemon natator**P. pelagicus**Planes minutus**Portunus sayi**P. spinimanus**Sergestes oculatus**Tozeuma carolinense**Virbius acuminatus*

## Order Isopoda

*Anatanais normani**Bagatus minutus**Bopyroides latreuticola**Bopyrus squillarum**Idotea baltica**I. metallica**I. whympersi*

Table 1. Contd.

*Janira minuta*  
*Paradynamene benjamensis*  
*Probopyrus latreuticola*

Order Amphipoda  
*Ampithoe longimana*  
*A. pelagica*  
*Biancolina brassicaecephala*  
*Caprella danilevskii*  
*Hemiaegina minuta*  
*Luconacia incerta*  
*Sunampithoe pelagica*  
*Vibilia pelagica*

Phylum Tardigrada  
 Order Heterotardigrada  
*Styraconyx sargassi*

Phylum Mollusca  
 Class Gastropoda  
 Order Mesogastropoda  
*Bittium* sp.  
*Litiopa melanostoma*  
*Rissoa* sp.

Order Thecosomata  
*Creseis spinifera*

Order Nudibranchia  
*Aeolidiella occidentalis*  
*Corambella depressa*  
*Cuthona pumilio*  
*Doridella obscura*  
*Doto pygmaea*  
*Fiana pinnata*  
*Glaucus atlanticus*  
*Scyllaea pelagica*  
*Spurilla sargassicola*  
*S. neapolitana*  
*Tethys protea*

Class Cephalopoda  
 Order Teuthoida  
*Onychia caribaea*

## Table 1. Contd.

Phylum Ectoprocta

Class Gymnolaemata

Order Cheilostomata

*Aetea anguina**Membranipora turberculata**Thalamoperella falcifera*

Phylum Chordata

Class Ascidiacea

Order Aplousobranchia

*Diplosoma gelatinosum*

<sup>a</sup> List compiled from Winge, 1923; Parr, 1939; Adams, 1960; Yeatman, 1962; Weis, 1968; Friedrich, 1969; Fine, 1970; Dooley, 1972; Morris and Mogelberg, 1973; Ryland, 1974; Teal and Teal, 1975; Peres, 1982; Butler et al., 1983; Deason, 1983; Stoner and Greening, 1984; and Morgan et al., 1985.

Table 2. Fishes associated with pelagic *Sargassum* in the North Atlantic and Gulf of Mexico.<sup>a</sup> \* = early life stage present (i.e. egg, larvae or juvenile). Nomenclature follows Robins et al. (1991).

<u>Family/Species</u>	<u>Common Name</u>
<b>Carcharhinidae</b>	
<i>Carcharhinus falciformis</i>	silky shark
<i>C. limbatus</i>	blacktip shark
<i>C. longimanus</i>	oceanic whitetip shark
<b>Clupeidae</b>	
<i>Sardinella aurita</i>	Spanish sardine
<b>Gadidae</b>	
<i>Urophycis earlli</i>	* Carolina hake
<i>U. floridana</i>	* southern hake
<b>Antennariidae</b>	
<i>Histrio histrio</i>	* sargassumfish
<b>Exocoetidae</b>	
<i>Cypselurus furcatus</i>	spotfin flyingfish
<i>C. melanurus</i>	* Atlantic flyingfish
<i>Exocoetus obtusirostris</i>	* oceanic two-wing flyingfish
<i>Hemiramphus balao</i>	balao
<i>H. brasiliensis</i>	ballyhoo
<i>Hirundichthys affinis</i>	* fourwing flyingfish
<i>Hyporhamphus unifasciatus</i>	silverstripe halfbeak
<i>Parexocoetus brachypterus</i>	* sailfin flyingfish
<b>Belonidae</b>	
<i>Tylosurus acus</i>	* agujon
<b>Fistulariidae</b>	
<i>Fistularia tabacaria</i>	* bluespotted cornetfish
<b>Centriscidae</b>	
<i>Macroramphosus scolopax</i>	longspine snipefish
<b>Syngnathidae</b>	
<i>Hippocampus erectus</i>	* lined seahorse
<i>H. reidi</i>	* longsnout seahorse
<i>Microphis brachyurus</i>	* opossum pipefish
<i>Syngnathus floridae</i>	* dusky pipefish
<i>S. louisianae</i>	* chain pipefish
<i>S. pelagicus</i>	* sargassum pipefish
<i>S. springeri</i>	* bull pipefish

Table 2 (Contd).

Serranidae	
<i>Epinephelus inermis</i>	* marbled grouper
Priacanthidae	
<i>Pristigenys alta</i>	* short bigeye
Apogonidae	
<i>Apogon maculatus</i>	* flamefish
Rachycentridae	
<i>Rachycentron canadum</i>	* cobia
Echeneidae	
<i>Phtheirichthys lineatus</i>	slender suckerfish
Carangidae	
<i>Caranx bartholomaei</i>	* yellow jack
<i>C. crysos</i>	* blue runner
<i>C. dentex</i>	* white trevally
<i>C. hippos</i>	* crevalle jack
<i>C. latus</i>	* horse-eye jack
<i>C. ruber</i>	* bar jack
<i>Chloroscombrus chrysurus</i>	* Atlantic bumper
<i>Decapterus macerellus</i>	* mackerel scad
<i>D. punctatus</i>	* round scad
<i>D. tabl</i>	* redbtail scad
<i>Elagatis bipinnulata</i>	* rainbow runner
<i>Naucrates ductor</i>	pilotfish
<i>Seler crumenophthalmus</i>	* bigeye scad
<i>Seriola dumerili</i>	* greater amberjack
<i>S. fasciata</i>	* lesser amberjack
<i>S. rivoliana</i>	* almaco jack
<i>S. zonata</i>	* banded rudderfish
<i>Trachurus lathami</i>	* rough scad
Coryphaenidae	
<i>Coryphaena hippurus</i>	* dolphin
Lutjanidae	
<i>Rhomboplites aurorubens</i>	* vermilion snapper
Lobotidae	
<i>Lobotes surinamensis</i>	* tripletail
Sparidae	
<i>Pagrus pagrus</i>	* red porgy

Table 2 (Contd).

## Mullidae

*Mullus auratus*

\* red goatfish

*Pseudupeneus maculatus*

\* spotted goatfish

*Upeneus parvus*

\* dwarf goatfish

## Kyphosidae

*Kyphosus incisor*

\* yellow chub

*K. sectatrix*

\* Bermuda chub

## Chaetodontidae

*Chaetodon ocellatus*

\* spotfin butterflyfish

*C. striatus*

\* banded butterflyfish

## Pomacentridae

*Abudefduf saxatilis*

\* sergeant major

*A. taurus*

\* night sergeant

*Pomacentrus variabilis*

\* cocoa damselfish

## Mugilidae

*Mugil cephalus*

\* striped mullet

*M. curema*

\* white mullet

## Sphyraenidae

*Sphyraena barracuda*

great barracuda

*S. borealis*

\* northern sennet

## Polynemidae

*Polydactylus virginicus*

\* barbu

## Labridae

*Bodianus pulchellus*

\* spotfin hogfish

*Thalassoma bifasciatum*

\* bluehead

## Blenniidae

unidentified

\* blenny

## Acanthuridae

*Acanthurus randalli*

gulf surgeonfish

## Trichiuridae

Unidentified

\* snake mackerel



Table 2 (Contd).

## Scombridae

*Acanthocybium solandri*  
*Auxis thazard*  
*Euthynnus alletteratus*  
*Katsuwonus pelamis*  
*Scomber japonicus*  
*Scomberomorus cavalla*  
*Thunnus albacares*  
*T. atlanticus*

\* wahoo  
 frigate mackerel  
 little tunny  
 skipjack tuna  
 \* chub mackerel  
 king mackerel  
 yellowfin tuna  
 blackfin tuna

## Xiphiidae

*Xiphias gladius*

\* swordfish

## Istiophoridae

*Istiophorus platypterus*  
*Makaira nigricans*  
*Tetrapturus albidus*

\* sailfish  
 \* blue marlin  
 \* white marlin

## Stromateidae

*Centrolophus* sp.  
*Cubiceps pauciradiatus*  
*Hyperoglyphe bythites*  
*H. perciformis*  
*Peprilus triacanthus*  
*Psenes cyanophrys*

ruff  
 bigeye cigarfish  
 black driftfish  
 barrelfish  
 \* butterfish  
 \* freckled driftfish

## Balistidae

*Aluterus heudeloti*  
*A. monoceros*  
*A. schoepfi*  
*A. scriptus*  
*Balistes capriscus*  
*Cantherhines macrocerus*  
*C. pullus*  
*Canthidermis maculata*  
*C. sufflamen*  
*Monacanthus ciliatus*  
*M. hispidus*  
*M. setifer*  
*M. tuckeri*  
*Xanthichthys ringens*

\* dotterel filefish  
 \* unicorn filefish  
 \* orange filefish  
 \* scrawled filefish  
 \* gray triggerfish  
 \* whitespotted filefish  
 \* orangespotted filefish  
 \* rough triggerfish  
 \* ocean triggerfish  
 \* fringed filefish  
 \* planehead filefish  
 \* slender filefish  
 \* pygmy filefish  
 \* sargassum triggerfish

## Ostraciidae

*Lactophrys* sp.

boxfish

Table 2 (Contd).

<u>Family/Species</u>	<u>Common Name</u>
<b>Tetraodontidae</b>	
<i>Chilomycterus antennatus</i>	bridled burrfish
<i>C. schoepfi</i>	striped burrfish
<i>Diodon holocanthus</i>	* ballonfish
<i>D. hystrix</i>	* porcupinefish
<i>Sphoeroides spp.</i>	* puffers
<b>Molidae</b>	
<i>Mola sp.</i>	sunfish

- <sup>a</sup> List compiled from: Beebe and Vee-Van, 1928; Breder, 1938; Berry, 1959; Caldwell, 1959; Gibbs and Collette, 1959; Adams, 1960; Berry and Vogele, 1961; Dawson, 1962; Stephens, 1965; Beardsley, 1967; Böhlke and Chaplin, 1968; Randall, 1968; Weis, 1968; Friedrich, 1969; Fine, 1970; Dooley, 1972; Hassler and Rainville, 1975; Teal and Teal, 1975; Hastings and Bortone, 1976; Bortone et al., 1977; Fedoryako, 1980; Schwartz et al., 1982; Manooch and Hogarth, 1983; Manooch and Mason, 1983; Manooch et al., 1984; Manooch et al., 1985; Carr, 1986; Fedoryako, 1989; Minerals Management Service, 1990; J. Govoni, pers. comm.; C. Manooch, pers. comm.; L. Settle, unpubl. data.